STRATEGIC ENERGY MANAGEMENT PLAN FOR THE 1990'S

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ABSTRACT

This paper describes the strategic energy management plan implemented by the Defense Systems and Electronics Group (DSEG) of Texas Instruments (TI) to enable it to meet its energy management challenge into the 1990's. The strategic energy management plan is the clear vision of energy management over the long term. It provides the focal point for an effective, integrated energy management program. Its components include a situation analysis; energy requirements and costs; issues, objectives, and strategies; action programs; plan results; and sensitivities and assumptions. Factors critical to its success include a policy statement, realistic goals, interactive planning, and an organizational framework.

COMPONENTS

Situation Analysis

Energy conservation efforts have made substantial progress in reducing DSEG's energy use and costs during the past decade. Energy conservation measures implemented include turning off unused lighting and equipment; equipment and process modifications; better utilization of equipment; and reduction of losses in building shells. These responses to survive the global energy uncertainties of the 1970's and early 1980's were made without a long-range, integrated energy management plan.

Now, DSEG is making a marked transition from energy conservation to energy management. It is an attempt to achieve the same level of productivity with a lower expenditure of energy, an adequate energy supply, and the lowest possible energy cost. An effective energy management plan has become an integral part of facilities management and strategic facilities planning.

This increase in the priority and role of strategic energy management planning in DSEG reflects the reality that energy resources are no longer going to be secure or inexpensive. Despite recent seeming improvement, the external energy environment is far from normal (Figure 1). Aspects of the forces responsible for the energy crises of the 1970's, e.g. OPEC, still exist. More importantly, immense international, economic, technological, and government forces have recently appeared and are inexorably changing the external energy environment. Examples of the latter forces include increasing dependence on imported oil, plummeting oil and natural gas prices, cogeneration, and the Public Utilities Regulatory Policy Act (PURPA).

To reckon with the changing external energy environment, DSEG's strategic energy management plan focuses on abundant opportunities to increase energy efficiencies and reduce energy costs. These opportunities include major process modifications, e.g. heat recovery, and the application of new technologies, e.g. variable speed pumping. The energy management challenge for the 1990's will be to balance the implementation of these opportunities with proven energy conservation efforts such as tuning of operations and maintenance projects involving small capital investments (Figure 2). Added to the above challenge are the traditional energy management challenges of management support, availability of funds, availability of manpower, effects of relatively stable energy prices, soliciting support for energy conservation projects, employee awareness and participation, and general energy awareness.

Energy Requirements and Costs

DSEG is a major segment of TI with 1986 net sales billed (NSB) exceeding $1.7 billion. DSEG designs, develops, and produces state-of-the-art defense systems and electronics in several major areas including radar/avionics, missile guidance

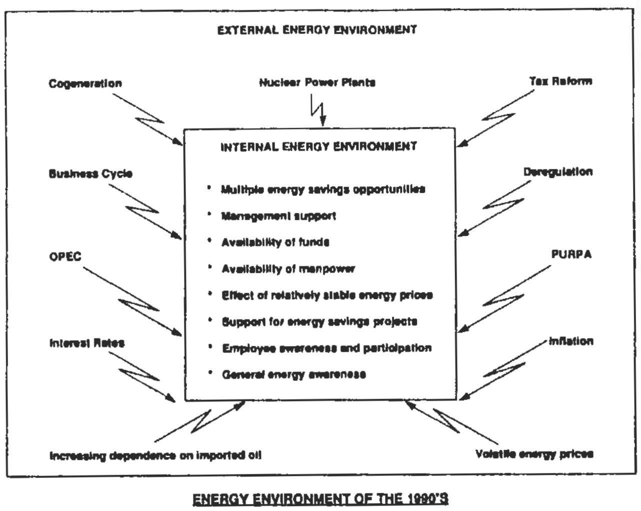

FIGURE 1. ENERGY ENVIRONMENT OF THE 1990'S

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and control systems, and electro-optics. DSEG owns and leases a large number and variety of facilities located primarily in north central Texas and totaling over 7.5 million gross square feet (GSF).

DSEG's energy requirements and costs derive from developing and producing its products and operating its facilities (Table 1). In 1986, space energy usage indices ranged from over 500 KBTU/GSF at DSEG's most manufacturing-intensive facilities to less than 150 KBTU/GSF at its least manufacturing-intensive facilities. DSEG is heavily reliant on electrical energy and energy cost indices ranged from over 14 $/MBTU to under 9 $/MBTU at its facilities in 1986. Resultant space energy cost indices ranged from over 6 $/GSF to under 2 $/GSF. Total energy requirements in 1986 exceeded 2.2 million MBTU and total energy costs exceeded $25 million.

Issues, Objectives, and Strategies

Understanding the key energy issues which DSEG will face in the 1990's and developing appropriate objectives and strategies to overcome these issues are important to the strategic energy management plan. The three key energy issues identified as being of great importance to DSEG's energy performance in the 1990's are energy costs as a percentage of NSB, heavy reliance on a single fuel source, and anticipated electric rate shocks.

Energy Costs as a Percentage of NSB: Although energy costs constitute only a small percentage of NSB, energy costs are significant to profitability. Furthermore, energy usage and costs are largely controllable. Many opportunities exist to further reduce energy usage and costs and the savings realized will contribute to profitability.

Appropriate objectives regarding this key issue are twofold: To reduce energy costs per dollar of NSB each year and to implement applicable avoidance measures to reduce energy costs.

Strategies to accomplish the energy cost objective include conserving energy at sources and end uses. Applicable energy source conservation strategies are reducing system losses, operating equipment efficiently, maintaining equipment properly, employing efficient equipment, recovering energy, and employing new technology. Applicable energy end use conservation strategies are optimizing lighting, motors, heating, ventilating, air conditioning, compressed air, steam, combustion, cooling, and exhaust as well as employing new technology.

Strategies to accomplish the cost avoidance objective include controlling demand, cogenerating and exploiting competitive rate making for electricity, and using interruptable service and exploiting supplier competition for natural gas. Employing the Texas sales tax exemption for energy usage at manufacturing facilities is also an applicable strategy for the cost avoidance objective.

Heavy Reliance on a Single Fuel Source: Heavy reliance, i.e. over 80% of energy usage and over 90% of energy costs, on a single fuel source, i.e. electricity, can cause serious problems if that fuel source is interrupted. Even short-lived interruptions can have serious consequences. Furthermore, many opportunities exist to use natural gas in lieu of electricity.

Appropriate objectives regarding this key issue are twofold: To insure reliability of supply for all energy sources and; to develop flexibility in energy usage.

Applicable strategies to accomplish the reliability objective are maintaining adequate plant electrical systems, exploiting deregulation of the natural gas industry, and maintaining adequate fuel oil storage. Applicable strategies to accomplish the flexibility objective are exploiting natural gas alternatives to electricity, using cogeneration where feasible, exploiting electric utility competition and wheeling, and employing combustion equipment capable of burning alternate fuels.

Anticipated Electric Rate Shocks: Large electric rate increases, i.e. 20-40%, will be experienced when Comanche Peak Nuclear Generating Units #1 and #2 come on-line in 1989-1990. There are two reasons for the importance of this issue; first, electricity accounts for over 90% of energy costs and; second, most uses of electricity cannot readily switch to other fuel sources, e.g. motors. The projected electric rate increases will have a significant adverse impact on energy costs.

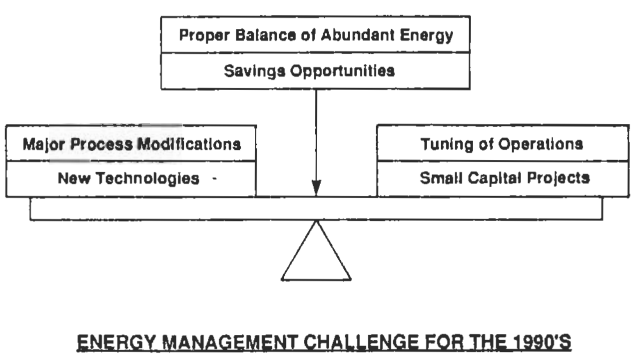

FIGURE 2. ENERGY MANAGEMENT CHALLENGE FOR THE 1990'S

TABLE 1

OVERALL ENERGY USAGE PROFILE

ENERGY USE	PERCENTILE
Manufacturing	40
Cooling	20
Heating	15
Ventilating	9
Lighting	9
Exhaust	2
Losses	2
Compressed Air	1
Convenience Power	2

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The appropriate objective regarding this key issue is to minimize the impact of electric rate increases on energy costs.

Applicable strategies to accomplish the above objective are energy conservation, load management, favorable electric utility rates, and cogeneration. The energy conservation strategy involves applying more emphasis on electricity usage reductions than on energy usage reductions from other areas. The load management strategy involves managing electrical loads so as to minimize demand charges, i.e. typically 30% of total electricity costs. This is within the capabilities of existing energy management systems. The favorable electric utility rates strategy involves purchasing electricity at transmission voltages, e.g. 138,000 V, to take advantage of the lowest available rates. This strategy requires the installation and maintenance of on-site primary substations. Lastly, the cogeneration strategy involves the option of self-generation of electric power and steam when favorable electric rates cannot be obtained. This strategy requires the installation and operation of absorption chilling equipment.

Action Programs

Action programs to implement the energy strategy measures outlined above are specified in DSEG's annual energy action program. This "blueprint" details the engineering, design, application, utilization, operation, and maintenance actions which DSEG site will complete during the year (Figure 3). It is an integrated compilation of energy action programs prepared by each site. This decentralized, "bottom-up" approach allows each site to "tailor" its energy action program according to its particular energy requirements, opportunities, weaknesses, and the like. Integration of the site energy action programs at the group level allows emphasis to be applied where common weaknesses evidence themselves, e.g. "sick" energy management systems at major owned buildings or leaving unused lighting and equipment on at satellite leased buildings.

Other energy action programs to implement the energy strategy measures outlined above include reviewing funding requests for capital projects as well as expense moves and rearrangements to insure that efficient energy utilization is included. An example of such a solution would be to supply 400 Hz power to an avionics testing laboratory with an electronic frequency converter rather than a motor-driven power generator. Also, designs and specifications for new plants and buildings are reviewed to insure that efficient energy utilization is "designed in." A example of the latter would be to finish out a small leased building with electric cooling/gas heating units rather than all-electric heat pumps.

Plan Results

Trend analysis provides some understanding of intermediate-term plan results in this large, varied, and rapidly growing enterprise. During the early and middle 1980's, DSEG's NSB increased at an average annual rate of 13% as did its GSF of space. During the same period, DSEG's energy usage increased at an average annual rate of 11% and its energy costs increased at an average annual rate of only 9%. By controlling energy usage and cost increases within business and space growth rates, the strategic energy management plan was able to contribute to profitability during a period of rapid expansion. DSEG's space energy usage indices, energy cost indices, and space energy cost indices were also favorable during this period. Of key importance, the index of energy costs as a percentage of NSB, i.e. the product energy cost index, declined by 9% during the period.

To date, these results of the strategic energy management plan show its effectiveness and demonstrate its potential as a facilities cost reduction tool. Its effectiveness and potential have become even more important given the priority of cost reduction in the business environment of the late 1980's.

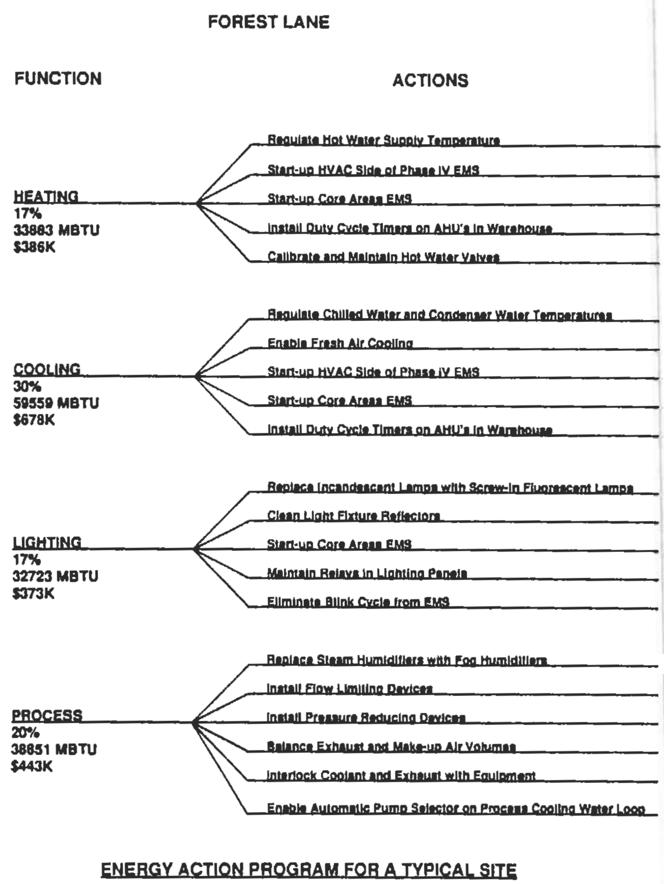

FIGURE 3. ENERGY ACTION PROGRAM FOR A TYPICAL SITE

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Sensitivities and Assumptions

DSEG's strategic energy management plan assumes that energy usage and costs are largely controllable. Based thereon, it emphasizes energy actions within the internal energy environment (Refer to Key Energy Issues #1 and #2). Energy actions within the external energy environment are limited to measures such as exploiting competition among energy suppliers.

Because the strategic energy management plan emphasizes energy actions within the internal energy environment, it is sensitive to changes in the external energy environment. The strategic energy management plan recognizes this area of sensitivity and outlines objectives and strategies to address anticipated changes in the external energy environment, i.e. electric rate shocks (Refer to Key Energy Issue #3).

Beyond anticipated changes in the external energy environment, the strategic energy management plan is also sensitive to unanticipated changes. As discussed earlier, immense and powerful forces such as OPEC, increasing dependence on imported oil, plummeting oil and natural gas prices, new technologies, governmental regulatory policies, and the like have the potential to quickly interrupt the seemingly normal conditions which currently appear to dominate the external energy environment.

CRITICAL FACTORS

Policy Statement

The energy policy statement is the focal point that creates identity, provides direction, and builds concensus and commitment. DSEG's energy policy statement contains the following elements:

* Reduce energy costs and maintain service effectiveness by increasing efficiency in energy usage and utility plant operations.
* Correct inefficiencies identified in surveys and audits by taking necessary maintenance or operations actions.
* Evaluate and undertake selected capital projects evolving from surveys and audits.
* Review designs of all capital projects, such as plant expansions or new processes, to insure that efficient energy utilization is included in the design.

It is readily discernible that management emphasis is placed on utility plant operations as well as source and end energy usage. Also, energy surveys and audits are designated by management as the central point from which energy actions evolve (Table 2). Management designates that maintenance and operations actions, i.e. expense measures, are equally as important as selected capital projects in correcting inefficient energy utilization. Lastly, management mandates that efficient energy utilization be "designed into" all capital projects.

Realistic Goals

Realistic goals challenge personnel and provide for performance measurement. They are important to freedom of action and timely problem sensing. The attainment of realistic energy goals contributes to high morale. DSEG's energy goal is:

- To reduce energy costs as a percentage of NSB.

This goal is realistic, but challenging, and is easily communicated and understood.

Interactive Planning

Interactive planning enables the energy management organization to effectively apply its efforts and resources toward implementing its energy action programs and achieving its energy goals. It is the central feature of the strategic energy planning process, and it is based upon principles from <u>In Search of Excellence</u>. As

TABLE 2

ENERGY CONSERVATION RECOMMENDATIONS

DENISON

1. Investigate payback for lighting control system using 5TI. If not justifiable, assign supervisor to turn out lights.
2. Investigate potential for reflectors and delamp on lighting system.
3. Check boiler for efficiency of operation. No regular check for efficiency.
4. Insulate steam return lines.
5. Inspect steam lines, traps, fittings, and make corrections, if necessary.
6. Check chiller operation for efficiency. Two chillers are run during winter at approximately 25-30% load. Chilled water setpoint is 42-43°. 1 chiller cycles off at around 38°F.
7. Investigate alternative means of dehumidification in summer months. Current method is to lower temperature setpoint to wring out moisture.
8. Install closed loop cooling on autoclave in plastics shop instead of once through water.
9. Check building temperature set-points. Current procedure is to change setpoint at whim of occupants.
10. Shutdown AHU during unoccupied hours where possible.
11. Investigate enthalpy control for AHU's with outside air capability. Dampers are set manually to maintain positive pressure in current use. Positive pressure may be a limitation for this recommendation.
12. Develop means of satisfying conflicting compressed air requirements. One area requires high pressure/low volume while autoclave requires low pressure/high volume.
13. Install timers on air compressors to shut off under no load conditions. Currently one compressor has a timer, the other of the two.

discussed earlier, the interactive energy planning process is comprehensive in that it addresses engineering, design, application, utilization, operations, and maintenance measures. It is participative in that each site prepares its energy action program according to its particular energy requirements, opportunities, weaknesses, and the like. Also, it is integrative in that the site energy action programs are compiled and coordinated at the group level with respect to priorities, resource allocation, and the like. Lastly, the interactive planning process is quite flexible in that it can be easily adapted to respond to sensed problems or to changes in the internal or external energy environment.

Organizational Framework

The strategic energy management plan relies, in large part, on the commitment and effort of members of the energy management "team" for its success. DSEG's energy management team organization is also based upon principles from In Search of Excellence and includes an energy management champion who is a senior facility manager; an energy manager who is experience in energy engineering and skilled in consulting, helping, and coordinating; and energy engineers from each plant or building who are facility engineers, utility plant supervisors, or the like. These personnel are "accountable" for energy usage and costs and are "responsible" for energy performance at their plant or building.

Communication is provided primarily by monthly energy management team meetings. At these meetings, each site energy engineer presents his site's accomplishments relative to its annual energy action program (Table 3). This forum allows the energy manager to review progress and provide guidance, instruction, support, and the like in an informal, two-way environment. Commitment and trust are reinforced by sharing ideas and accomplishments, identifying needs and opportunities, coordinating actions, and jointly setting expectations and goals. The monthly energy management team meetings are supplemented by periodic site visits by the energy manager and energy audits conducted by the site energy engineers on an "exchange" basis.

Energy usage and costs are continuously forecasted, monitored, and documented by powerful, sophisticated accounting databases and models. The reports generated by these accounting databases and models are current and accurate and receive considerable management attention. The accounting databases and models also produce energy performance indices for space energy usage, energy cost, and space energy cost which are used by management for comparison and evaluation. Operations research tools such as energy usage profiles and energy cost profiles are used to identify energy savings opportunities, and engineering economics tools such as simple payback analysis and life cycle cost analysis are used to evaluate energy savings projects. Following the implementation of energy savings projects, field data is collected and analyzed to document the effectiveness of the project (Figure 4).

The overall performance of the energy management organization and its progress in reducing energy usage and costs are monitored by management on a quarterly basis. This formal review covers policies, organization, goals, accomplishments, plans, critical issues, and financial results and forecasts. Management uses this forum to provide guidance and leadership, communicate expectations and feedback, and provide support. Management recognizes excellence in energy management by annually designating the "Most Energy Efficient Site" and "Most Cost Effective Utility Plant." Individual contributions that reduce energy usage and costs are recognized by the Method Improvement Report program.

TABLE 3

SIGNIFICANT ACCOMPLISHMENTS FOR
1ST QTR 1967

SHERMAN

- Started up heat recovery unit on thermal oxidizer. Heat recovery reduced building boiler load by 70-80%.
- Installed 5TI lighting controls in Rayburn Building. Reduced electrical usage 34%, electrical bill 23%.

LEWISVILLE

- Utilized silverized reflectors to upgrade lighting in wings A, B, C, D & G. Avoided increased wattage.
- Replaced steam humidifiers with fog type. Eliminated electrical usage related to humidification.

MCKINNEY

- Started up two new high efficiency chillers and auxilary equipment.
- Installed automatic variable speed drives on process water pumps. Reduced electrical usage by 50%.

FOREST LANE

- Installed duty cycle timers on warehouse AHU's reduced energy demand 60%.
- Reduced hot water temperature from 180° to 160°, reduced gas usage 52%.
- Reset chilled and condenser water temperatures and sequenced chiller operation. Reduced chiller electrical usage 12%.

LEMMON AVENUE

- Replaced six old and inefficient AHU's with one efficient unit in Metal Joining.
- Installed "Fast Roll" door in building envelope. Reduced infiltration of unconditioned air.

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TEXAS INSTRUMENTS
ENGINEERING EVALUATION REPORT

1

3/9/87

Document Savings in Natural Gas Use and Cost by Resetting Hot Water Supply Temperature

	Before	After	Reduction	%
Month	Feb 86	Feb 87	—	—
Heating Degree Days	400	387	13	3.25%
Setpoint	180°F	160°F	20°F	11.11%
Nat. Gas	39196 CF	18740 CF	20456 CF	52.19%
Energy	40.57 MBtu	19.40 MBtu	21.17 MBtu	52.19%
Cost	$17092.95	$ 7926.77	$9166.15	53.63%

Don Fiorino 3/9/87 Forest Lane 1/1

FIGURE 4. EVALUATION OF THE EFFECTIVENESS OF AN ENERGY ACTION

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